JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 14 JANUARY 4, 1924 No. 1

THE FOSSIL SWAMP DEPOSIT AT THE WALKER HOTEL SITE, CONNECTICUT AVENUE AND DE SALES STREET, WASHINGTON, D. C.[1]

FORMATIONS EXPOSED IN THE EXCAVATION

CHESTER K. WENTWORTH, GEOLOGICAL SURVEY

INTRODUCTION

Early in August, 1922, S. E. Godden, publicity manager of the Allen E. Walker Organization, called the attention of the United States Geological Survey to the stumps of trees and other vegetable remains that were being brought to light in the excavation for the foundation and basement of the new Walker Hotel, located at Connecticut avenue and DeSales street, N. W., Washington, D. C. DeSales Street is an east-west street, only one block long, about half way between L and M streets and between Seventeenth street and Connecticut avenue. The excavation is about 450 feet long and 150 feet wide.

The writer, who at the time was engaged in a critical study of terrace phenomena in the vicinity of Washington, under the auspices of the Geological Survey, examined the section at intervals of two or three days as the work progressed, until the 15th of September, when he left the city. The following paper is based in part on the writer's personal observations and in part on notes later furnished to him by Messrs. L. W. Stephenson and Laurence La Forge, during the continued progress of the work. Samples of the different formations were collected, but these have not as yet been critically studied in the laboratory.

[1] Papers presented at the 176th meeting of the Washington Academy of Sciences held jointly with the Geological Society of Washington, the Biological Society of Washington, and the Botanical Society of Washington, the evening of Wednesday, March 14, 1923.

The writer is indebted to Mr. Godden, to F. F. Gillen, engineer in charge of the excavation, and to several of the workmen for courtesies and assistance rendered during his examination of the section.

The present surface of the ground at the block bounded by Seventeenth and Connecticut avenue and DeSales street and L street has an altitude of 50 to 57 feet above sea level. The depth of the excavation for the foundation of the hotel was 35 to 40 feet, making the range of altitude of the bottom of the cut 15 to 22 feet above sea level.

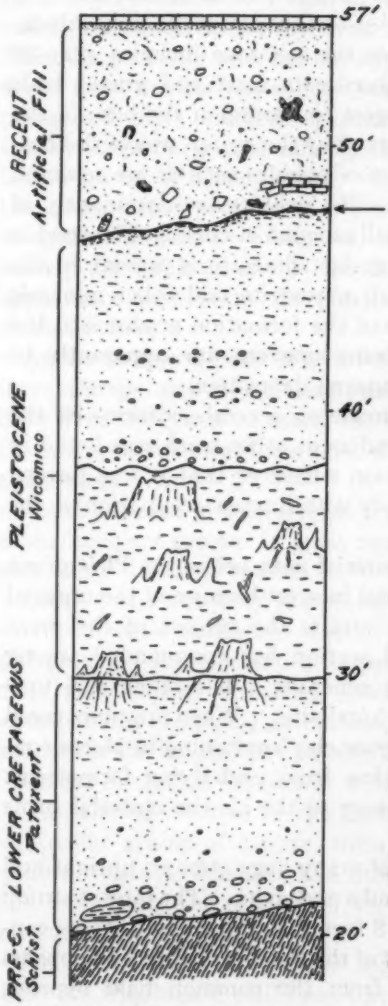
THE SECTION

Five different formations were exposed in the section afforded by the excavation, the thicknesses and general relations of which are shown in the generalized columnar section (Fig. 1). These formations from above downward were as follows:

(1) Artificial fill.
(2) Pleistocene loam, sandy clay, sand, and gravel.
(3) Pleistocene swamp silt or muck.
(4) Cretaceous sand and gravel.
(5) Pre-Cambrian schist.

DESCRIPTION OF FORMATIONS

Artificial fill. This material consists of a mixture of loam, clay, and sand, and varies in thickness from nothing at the northeast corner of the excavation to a maximum of 13 feet near the middle of the west side, the difference in thickness being due to the irregular configuration of the original surface on which the material was dumped. The material is likewise somewhat variable in composition and has little regularity of structure. Overlapping of different phases indicates the shifting of sources of the material dumped and of the directions of accumulation. Various materials of human source, while not quantitatively of great importance, are sufficiently abundant to indicate deposition of the material contemporaneously with the activities of civilized man. The shapes and conditions of fragments of these materials together with the crude non-stratified character of the deposit show conclusively that it is artificial fill. Bits of coal, brick, tile and other pottery, tin cans, oyster shells, and occasional fragments of glass, leather, and metals are the most abundant relics found in this formation. A brick pavement, said to have been part of the cellar floor of the old convent which stood at the west end of the hotel site, and an old stone wall, extending two or three feet below the base of the fill, were exposed along the west side of the excavation.



Brick sidewalk at present street grade.

Unassorted mixture of gravel, loam, and clay. Contains a variety of articles of human source, such as bricks, tile, coal, cinders, glass, tin cans, and metal and leather fragments. 0 ft. to 13 ft.

Peat—a thin layer of carbonaceous material at the contact between the fill and the underlying sandy loam. 0 in. to 0.5 in.

Light gray loam, sandy clay, sand, and gravel, in places slightly mottled with buff. The material is poorly assorted and includes bands and lenses of pebbly sand. Wicomico formation. 5 ft. to 15 ft.

Light brown highly carbonaceous silt or swamp muck, containing tree stumps and wood fragments; turns black when exposed to air. 6 ft. to 9 ft.

Clay, sand, and gravel. Ranges from sandy clay above to coarse gravel at the base; finer material is a rich micaceous, little assorted gray-green geest from the underlying schist; the pebbles of the gravel are composed of a great variety of rocks from many parts of the Potomac basin, and the gravel is far less dominantly quartzose than the Pleistocene gravels of this region. The deposit is a basal phase of the Patuxent formation. 7 ft. to 12 ft.

Schist, considerably weathered but still compact.

Fig. 1. Generalized columnar section of formations exposed in the excavation.

Pleistocene loam, sandy clay, and gravel. At the top of this layer is a thin carbonaceous or peaty band containing small fragments of vegetable material. This band is an inch or less in thickness and is absent in some places; it is underlain by a soil zone 6 to 12 inches thick.

The main body of this layer below the soil zone includes gray to buff sandy clay and loam, and subordinate sand and gravel beds alternating with little order with respect to the top or the base of the section. The bedding, so far as observed by the writer, was of the cut-and-fill type, with stringers and zones of pebbles such as are common in the Pleistocene terrace deposits. The pebbles are dominantly of quartzite and vein quartz with a small amount of chert. The sand is almost wholly composed of quartz grains; ilmenite is present to the extent of perhaps one per cent, with muscovite and other minerals in much less abundance. The base of the formation grades into the swamp muck below, the contact being uneven, due apparently to differential leaching or perhaps to uneven deposition.

Though considerable search was made on several occasions by the writer and others, no brick, coal, cinders or other trash was found in this layer and there was no indication whatever that it was formed artificially or even contemporaneously with human occupation of the region.

Pleistocene swamp muck. The material next below the Pleistocene clay, sand, and gravel is of exceptional interest because of the unusual amount of fossil wood it contains, and is the subject of the great attention which the Walker Hotel section has commanded among scientists and residents of the city generally. The muck is 6 to 9 feet thick and underlies the entire hotel site. When first uncovered it is a light brown, highly carbonaceous clay containing in places considerable sand and many mica flakes from underlying formations. Within a minute or two after exposure to the air the material turns very dark, almost black.

The wood is present in the form of many huge stumps, upright and in place, and broken fragments of limbs and roots. The largest stump measured by the writer was about 8 feet in diameter but others considerably larger are reported. Most of the wood is cypress and appears to differ, in no essential respect from the common bald cypress, *Taxodium distichum*. In addition to the cypress wood, which includes stumps, roots, knees, and a few logs, numerous seeds and leaves of cypress were found. The seeds of other plants also occur, but these are less common than the cypress. Little alteration of the wood has taken place. It is water-soaked when first dug out and checks on

drying, becoming a little harder and firmer, but not "hard as iron" as has been reported. Like the green wood of recent cypress this fossil wood becomes very light in weight when dried. The stumps are rudely truncated at the top in an irregular but not splintery fashion. This abrupt upper termination appears to be due to subaerial rotting at or near the surface of continuous soil moisture, such as affects posts and poles erected by man. Likewise the scarcity of great trunks seems to be explicable by the rotting which usually takes place before burial is accomplished. Apparently only the smaller limbs, the stumps, and portions of a few larger trunks were buried or submerged in time to be preserved. No one has observed an authentic ancient axe mark on any of the stumps, and there is nothing in their appearance to warrant the popular opinion that the trees were cut down by man.

As the swamp deposit is 6 to 9 feet thick there is room for at least three stumps, one above the other, and as the individual trees must have lived 200 years or more, the time required for the deposition of the swamp muck must have been at least 600 years and may have been a thousand years.

Fossil remains of microscopic fresh water plant organisms, known as diatoms, are present in great numbers in the muck and they represent many different species.

Lower Cretaceous sand and gravel, Patuxent formation. Beneath the swamp muck is micaceous clay silt, which grades downward to sand and gravel. This formation is penetrated in its upper part by the roots and rootlets extending downward from the tree stumps preserved in the overlying formation; some of the roots extend 3 or 4 feet below the base of the swamp deposit. The finer portions of the Patuxent formation are almost wholly derived with little sorting from the weathered detritus of the underlying schist. The sands consist of angular grains of quartz, mica, garnet, tourmaline, hornblende, epidote, titanite, ilmenite, and other minerals, rudely assorted as to size, but clearly the product of very limited transportion, probably a few rods at most.

The gravel likewise contains angular blocks of the schist, though these are fragile and could not have been carried far. On the other hand, the bulk of the pebbles and boulders of the gravel, some of which range up to two feet or more in diameter, are of rocks foreign to the immediate vicinity.

G. W. Stose and Miss A. I. Jonas have very kindly made annotated identifications of the pebbles of a collection from this formation. On

the basis of these identifications the following composition was determined by the writer for 423 pebbles of diameters ranging from 8 to 16 millimeters:

	No. of pebbles
Vein quartz	109
Harpers schist	79
Chert, black and gray	63
Cambrian quartzite	64
Chloritic vein quartz	37
Epidotic greenstone, amygdaloidal	23
Triassic sandstone	13
Gray Weverton quartzite	13
Wissahickon schist	11
Garnetiferous and other granite	5
Sericitic quartzite	1
Hematitic Weverton sandstone	2
Pre-Cambrian apo-rhyolite	3
Total	423

It is apparent from this list that the sources of the pebbles of the gravel are widespread over the Potomac basin and that transportation must have been comparatively rapid and weathering relatively slight during the epoch of its origin.

Pre-Cambrian schist. This ancient rock is a highly metamorphosed rock of gray-green color and schistose structure. It was clearly eroded to a relatively plane surface before the deposition of the overlying gravel but not all the weathered rock was removed at that time. At the surface, which was the only part seen by the writer, it is moderately compact and serves as an adequate basement for the heavy concrete walls and foundation, though it can be picked and wedged loose with a pick or hammer.

AGE RELATIONS OF THE FORMATIONS

The uppermost of the five formations is generally recognized by all observers to be of artificial origin and of very recent date. The persistent correlation of the tree stumps of the major swamp layer with the trees and swamp conditions which are remembered by some of the older inhabitants leads to the interpretation of the clay, sand, and gravel of the second formation as likewise artificial or at least of an origin contemporaneous with the growth of the modern city. The writer is convinced that this correlation and the consequent interpretation are wholly erroneous. He considers that the recent surface with

Fig. 2. General view of the east end of the Walker Hotel excavation. The steam shovel near the northeast corner is engaged in removing the materials of the Pleistocene swamp deposit, the top of which lies just below the level on which the hoisting machinery stands. Photograph reproduced by courtesy of the Walker Hotel Organization.

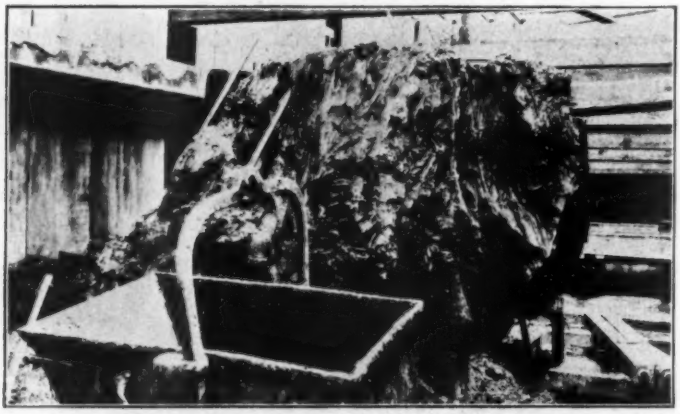


Fig. 3. One of the larger cypress stumps still in place but exposed and portions of it cut away in the process of digging. Sheet piling and one of the loading buckets are also prominent in the picture.

Fig. 4. One of the large cypress stumps from the Walker Hotel excavation, after it had been uncovered and lifted to the surface. By courtesy of the Walker Hotel Organization.

Fig. 5. Portion of a stump and roots still in place in the swamp muck on the north side of the excavation.

Fig. 6. View showing the edge of the swamp deposit into which the steam shovel is cutting. The form of a mud covered cypress stump upright and in place in the muck is indistinctly shown just to the right of the overturned bucket.

its vegetable mantle is represented by the thin peaty layer immediately below the fill, and that the clay, sand, and gravel, which is clean and devoid of artifacts, is of Pleistocene age.

The formation which lies immediately under the artificial fill is believed to have been formed during the latter half of the Pleistocene period, that is, during the latter half of the great ice age, an opinion based on the topographic position of the formation and its relation to the terraces that have been differentiated in this region. The terrace on which the portion of the city from K street northward to Sixteenth

Fig. 7. Photograph showing the character of the Patuxent gravel. This was a source of considerable water which kept the lower part of the cut constantly wet and during the off duty periods washed the gravel and kept it clean and bright, greatly facilitating its examination for various kinds of rocks and shapes of pebbles.

and U streets is built has long been known as the Wicomico terrace, and the loam, sand, and gravel underlying the terrace surface has been known as the Wicomico formation. The swamp deposit must necessarily have been formed at least a little earlier than the Pleistocene terrace deposit that overlies it, but there is no reason to believe that it is very much older. The swamp deposit is therefore referred to the early part of the Wicomico stage of the Pleistocene epoch.

The question is frequently asked, "How long in years has it been since the fossil trees found in this swamp deposit were living trees?" This can not be answered definitely. If the swamp deposit was formed during the latter half of the ice age, it must have been many thousands of years ago. In the first press notice that was given out by the writer, the figures 20,000 or 30,000 years were mentioned. The biological evidence, however, as presented in the papers which follow this one, indicate that the climatic conditions during the formation of the swamp deposit were milder than at present. This suggests that the deposit was formed during one of the interglacial stages. If it was

formed during the last interglacial stage, the Peorian, which immediately preceded the last glacial stage, the Wisconsin, a conservative estimate of the age of the swamp would be 100,000 years, and it may be much older.

The gravel and sand deposit below the swamp layer is confidently assigned to the Patuxent formation (Lower Cretaceous) on the ground of its topographic position and lithologic character. However, no fossils have been found to corroborate this correlation. The deposit lies against the eroded edge of the Piedmont Plateau and is exposed with this relation at many places in the vicinity.

The unconformity which separates the Patuxent formation from the overlying swamp deposit represents an exceedingly long interval of time, including the Upper Cretaceous epoch, the Tertiary period, and the early part of the Quaternary period. No strata are preserved in this section which were laid down during this long interval. The unconformity which separates the Patuxent formation from the underlying basement schist represents a period of time of even greater duration than does the unconformity at the top of the Patuxent, for it includes all of Paleozoic and most of Mesozoic time.

Though in this section there is presented an unusually interesting record of the conditions and history of past ages, there is no suggestion that any part of this history was unusual or exceptional at the time. The geologist knows that slowly and surely the products of nature are wrought, and that only in the fore-shortening of such a record as the one in question does one process seem to succeed another in an abrupt manner. There is to him no problem as to "What disaster overwhelmed the vast forest and crumpled it into a solid mass of crushed wood, shearing off these big trees as a man might cut grass with a scythe?" a question recently asked by a writer in Popular Mechanics with reference to this excavation. He can only hope that less and less as years go by will these relics of catastrophism persist in the popular mind.

ORGANIC REMAINS, OTHER THAN DIATOMS, FROM THE EXCAVATION

EDWARD WILBER BERRY, THE JOHNS HOPKINS UNIVERSITY

The present imperfect contribution is, so far as I know, the first illustrated account of fruits and seeds from an American Pleistocene deposit—a much neglected field of research in this country, but one that has been cultivated with great distinction in northern and central Europe.

As at the inauguration of work of this kind in Europe, I have felt the need of adequate collections of comparative material. Herbaria are almost useless, and carpological collections like those of the seed division of the Bureau of Plant Industry or that of the Biological Survey, built up with other ends in view, are not altogether satisfactory. I take much pleasure, however, in expressing my appreciation of assistance from Edgar Brown of the former and W. L. McAtee of the latter bureau, and to E. P. Felt of Albany for his determination of *Retinodiplosis*.

The determined fossils obtained by washing a large amount of the argillaceous peaty material, carefully sorting it under water, and then drying and impregnating it with paraffin has involved an enormous amount of labor—a few ounces of prepared specimens being the result of the washing of 100 pounds of the material.

I cannot say that the results are decisively significant. The species identified represent with scarcely an exception such an assemblage as might be obtained in southern Maryland or Virginia at the present time. A substantially similar representation is to be found in the present flora of the District of Columbia, but the latter area does not include all of the species found among the fossils, and although the majority of the fossil forms do still inhabit the District several would not be likely to be present at the Walker site even though the latter had remained uninhabited.

There are recorded 28 more or less definitely named species of plants, as well as several undetermined and immature forms. Several species of galls were isolated. Of these two are figured and identified. One of these is present in great abundance. No beetle or other similar insect remains, such as are usually to be found in such deposits, were encountered, but bits of chitin and insect egg cases were present, as was also what appeared to be rodent dung.

The plants represent 19 families and include 1 gymnosperm, 8 monocotyledons, and 19 dicotyledons. Thirteen are positively determined specifically and all of these represent still existing species; 5

additional are given tentative specific names; and the balance are merely identified generically. By far the most abundant remains were those of the bald cypress, grape, elderberry, *Rubus*, and sedges. As regards variety, the sedges furnish the most abundant element, six species representing the genera *Carex*, *Scirpus*, *Cladium*, and *Dulichium* being present—*Carex* and especially *Dulichium* in great abundance; and there are in addition various unidentified remains of sedges representing *Carex*, *Scirpus*, and possibly *Cyperus*.

By far the most abundant single species represented was the bald cypress. All of the trunks, many of large size, seen in the excavation were of that species, and were present at successive levels; the peaty clays were also filled with their root systems and knees. In the washed and sorted material also the cypress was overwhelmingly represented, chiefly by seeds, there being relatively few cone scales. Pointing in the same direction was the abundance of cypress cone galls of the genus *Retinodiplosis*, and those of the cypress leaf gall of the genus *Itonida*.

Some critics, opposed to the antiquity of the deposit, have made much of the absence of prostrate logs. I have seen at least a score of similar Pleistocene swamp deposits, as well as many subfossil and recent ones, and prostrate logs are as rare in these as in the Walker deposit. They are not absent in the last and the reason for their rarity is clearly indicated by the accompanying photograph of such a log collected by Dr. Stephenson and photographed by Mr. Brown (Plate 3, fig. 1). It will be noted that this is part of a large log, the submerged portion of which was preserved, although the part exposed to the air had decayed before the growth of the deposit buried it. For other records of prostrate logs seen in the Walker deposits I am indebted to Dr. David White.

In trying to picture the environment as indicated by the plants alone, and for the moment ignoring the strictly geologic and physiographic data, it may be noted that the following, represented by fossils in this deposit, are found at the present time in swamps or marshes, or in standing and slow-moving water: *Taxodium*, *Sparganium*, *Naias*, *Carex*, *Scirpus*, *Cladium*, *Dulichium*, *Polygonum*, *Castalia*, *Ceratophyllum*, *Ranunculus*, *Vitis*, *Ampelopsis*, *Cornus*, *Leucothoë*, *Sambucus*, and *Viburnum*.

This list includes not only the majority of the species represented but nearly all that it has been possible to name specifically. Not only is this the case, but all but two of the remaining forms are species of

low woods and thickets, namely: *Chenopodium, Rubus, Prunus, Acalypha, Galium,* and *Ilex.*

Only two of the fossils may be definitely assigned to various situations. These are *Phytolacca decandra* and *Viburnum prunifolium* and both might normally be found associated with the foregoing. The plants therefore may be said to point overwhelmingly to a slow stream with seasonal or permanent ponds along its course bordered by low woods and thickets, with occasional glades. The geologic occurrence and the presence of numerous huge cypress butts prove *a priori* what has just been deduced from the seeds and fruits identified.

The species represented, as is true of aquatic and water-side plants to a greater degree than to plants of other situations, are for the most part long-lived and widely distributed species. The *Ceratophyllum* is found practically throughout North America; several occur in Europe or Asia, a further indication of antiquity; and the majority are found to range from southern Canada or New England to Florida.

Those not found in the existing flora of the District are: *Taxodium distichum, Naias marina, Scirpus lacustris, Cladium* sp., *Ampelopsis* sp., and *Chenopodium hybridum* (?).

Others which are extremely rare or altogether absent on the Piedmont and which are Coastal Plain species in this latitude are *Ilex opaca, Rubus hispidus, Carex intumescens,* and *Leucothoë racemosa.*

The bald cypress is preeminently a Coastal Plain species toward its present northern limits; in fact the so-called Fall Line is of considerable importance as a floral boundary in this region, as was clearly shown by Shreve in his Plant Life of Maryland.

Although it is not brought out with any great precision, a perusal of the ranges of the existing representatives of the fossils indicates that their general facies is southern rather than northern. The only form represented which might seem opposed to this interpretation rests on the validity of comparing the fossil *Chenopodium* with the existing *Chenopodium hybridum.* Nullifying this, as is pointed out under the discussion of that specimen, is the fact that almost any species of *Chenopodium* might, and occasionally does, have fruits as large as *C. hybridum.* I am therefore decidedly of the opinion that the fossil assemblage indicates slightly more genial climatic conditions than those which prevail at the present time in the District. It is conceivable that such an association might live in the District at the present time, but this southern facies and the distinctly Coastal Plain character of so many of the forms suggest that at the time they lived the Walker site was nearer sea level; or, stated another way, that

considerable areas of the present Coastal Plain were covered by the sea or penetrated by estuaries due to a much more extensive drowning of stream valleys than obtains at the present time.

With regard to the age of the deposit the decisive evidence must be that from the geological side. There were relatively few Pleistocene plants that are not still existing, and in a region such as this, situated in the middle Atlantic slope both at present and during the Pleistocene, the limits of range of the flora as a whole extend for long distances both to the northward and southward. In the absence of decisive elements the only estimate of age is that furnished by changes in range of the plants represented, and, as has been stated, these would be unlikely to be considerable in this situation (in respect to latitude, and situated in a relatively permanent river valley).

We have seen that these changes actually are slight, but that there have been some changes, and that certain species have withdrawn slightly to the southward, or more completely seaward in the present Coastal Plain, or both.

This points to a reasonable antiquity, as do the thickness of the deposit and the presence of large cypress butts at various levels. Adverse arguments based upon the freshness of preservation of the material are without the slightest force. I have seen fresher-looking wood from the Tertiary brown coal of Germany, where chemical tests reveal the presence of unaltered cellulose, and this is also said to be true for the inconceivably ancient Paleozoic coal in the province of Tula in Russia. I have collected equally modern-looking material from the Coastal Plain Upper Cretaceous. I see no reason for doubting the Pleistocene age of the deposit, which is indeed confirmed by other lines of evidence, and also by the exact similarity between the Walker deposits and others in tidewater Maryland and Virginia where the geological evidence is overwhelmingly positive.

At the same time I would deprecate the opinion of some students that this and similar deposits elsewhere along our Atlantic border are necessarily tens or hundreds of thousands of years old. I concede that such may be the case, but there is certainly no botanical evidence that the Walker plant bed is older than late Pleistocene.

GYMNOSPERMAE

TAXODIUM DISTICHUM (L.) L. C. Rich.(Pl. 1, f. 37–42; pl. 3).

It is probably impossible to differentiate *Taxodium distichum* from *Taxodium imbricarium* by means of the seeds and cone-scales. The stumps, which with the root systems and knees make up the bulk of the fossil swamp deposit, appear to be those of the former rather than the latter species.

The cone scales are not uncommon, but were apparently more perishable than the seeds, which are the most abundant objects present in the deposit. Both are characteristic. It is of interest that next in abundance are the galls of the midge, *Retinodiplosis taxodii*, or its immediate ancestor.

The bald cypress has a most interesting history and its immediate ancestor attained a Holarctic distribution during the Tertiary. The present species makes its appearance in geological record in the Pliocene of Alabama, and it was very common in southeastern North America during the Pleistocene, at which time it extended its range both northward and inland beyond its modern limits. It has been recorded from the Pleistocene in New Jersey, Delaware, Maryland, Virginia, North Carolina, Georgia, Florida, and Alabama.[1]

At the present time the bald cypress is confined to the Coastal Plain in this latitude, reaching its northern limits in southern Delaware and southern Maryland. It has not grown naturally in the District of Columbia in historic times. The Flora of the District (Washington, 1919) mentions it at Marshall Hall, Maryland, about 20 miles down the Potomac valley from the Walker Hotel site, but I have not observed it under unquestionable natural conditions nearer than southern Charles County, some miles distant.

That the Walker deposit was many years in formation is indicated by the section of a cypress log, between two and three feet in diameter, which is shown on Plate 3, figure 1. The lower third of this log, presumably buried in the more or less antiseptic swamp waters, was preserved, while the exposed two-thirds was subject to atmospheric conditions and hence decayed before the growth of the deposit was sufficient to entomb it. Cypress wood decays much more slowly than do most woods, and this possibly gives some measure of the rate of accumulation of the swamp deposit.

A section of one of the large pneumatophores or knees of the cypress, which are so common in the swamp deposit, is shown on Plate 3, figure 2.

ANGIOSPERMAE

MONOCOTYLEDONAE

SPARGANIUM EURYCARPUM Engelm. (Pl. 1, f. 36)

This nut-like fruit, about which I entertained some doubt regarding its identity, has been positively determined for me by W. L. McAtee as identical with the recent fruits of this species.

The broad-fruited bur-reed, as it is called, is found in marshes and along streams from Newfoundland to Virginia and westward to British Columbia and California. It is the only identified form in the collection whose modern range is for the most part north of the Potomac River. It is frequent in swamps and along the marshy margins of streams in the District of Columbia at the present time.

[1] See Berry, E. W.: *Tree ancestors* 56–67. 1923.

The genus goes back to Eocene, and possibly to Upper Cretaceous times. It is common in European Pleistocene deposits, but there is only one other American record, that of its occurrence in the Pleistocene of North Carolina.[2]

NAIAS sp. (Pl. 1, f. 1–3)

Several specimens in the collection represent this genus. It has not been possible to positively determine them specifically, although among existing species they are most similar to those of *Naias marina* L. The pericarp is large, 2 to 4 mm. in length with a prominent, persistent style and a somewhat rugose surface. *Naias marina* is found in the existing flora of both North America and Europe in lakes and ponds. On the former continent it ranges from central New York to Florida, but it has not been recorded from the District of Columbia or Maryland. Three other forms of *Naias* are present in the District, but the fossil appears to be distinct from these. The genus goes back to the Eocene; there are three extinct species in the Pliocene of Holland, and four species have been found in interglacial deposits in Germany. No others are known from the American Pleistocene.

CAREX cf. COLLINSII Nutt. (Pl. 1, f. 4–8)

Achenes small, triangular-fusiform, widest medianly, and about equally narrowed to the base and to the long, flexuous persistent style. This form is exceedingly common in the collection. It appears to represent *Carex collinsii* Nutt., a species of swamps, ranging from Rhode Island to Georgia, and apparently rare in the present flora of the District, from which there is but a single record.

The genus is an old one and is supposed to date from the Upper Cretaceous. Many species have been recorded from the Pleistocene of Europe. The American Pleistocene records include Scarboro, Ontario;[3] Greens Creek, Ontario;[4] Tennessee[5] and Florida.[6]

CAREX cf. INTUMESCENS Rudge (Pl. 1, f. 9–11)

Achenes triangular-fusiform, stout, with an expanded base, narrowing upward into a long, stout, flexuous style. Not uncommon in the collection but much less abundant than the preceding. Carices are determined with extreme difficulty and there are so many species that it is extremely hazardous to attempt the identification of fossil material. Nevertheless the present fossils are extremely close to *Carex intumescens* Rudge, which occurs in swamps and wet woods from Newfoundland to Manitoba, and southward to Florida and Louisiana. In the present flora of the District this species is apparently confined to low wet woods of the Coastal Plain.

[2] Berry, E. W., Torreya **14**: 160. 1914.
[3] Coleman, A. P., Journ. Geol. **3**: 626. 1895.
[4] Penhallow, D. P., Geol. Soc. Am. Bull. **1**: 325. 1890.
[5] Berry, E. W., Torreya **22**: 11. 1922.
[6] Berry, E. W., Florida Geol. Surv. 9th Ann. Rept. 22. 1917.

SCIRPUS cf. LACUSTRIS L. (Pl. 1, f. 12)

Achene distinctly obovate in outline, plano-convex, mucronate. Bristles considerably longer than the achene. Several poor and one fairly satisfactory specimen were found, apparently representing *Scirpus lacustris* L., a species that is widely distributed in ponds and swamps throughout North America, and present also in Europe. It is not recorded in the Flora of the District.

Species of *Scirpus* are common in the European Pleistocene, but no others are known from North American deposits of this age except *Scirpus fluviatilis*, which is recorded by Coleman[7] from Scarboro, Ontario.

SCIRPUS cf. AMERICANUS Pers. (Pl. 1, f. 13–15)

The fossil achenes are smooth, biconvex, obovate in outline, and prominently beaked. The bristles are not preserved. They appear to represent *Scirpus americanus* Pers., which, in the existing flora, is found in both brackish and fresh water swamps. It is widely distributed throughout North America, and is reported from South America. In the Flora of the District it is reported as infrequent in open marshy situations on the flood plain of the Potomac River.

CLADIUM sp. (Pl. 1, f. 16)

A single achene in the swamp deposit is definitely referable to the genus *Cladium*, a genus with about 30 existing species, of which three are found in the United States—one eastern, one southern, and one on the Pacific coast. The fossil is much like the species of *Cladium* found in the early Pleistocene of Europe. It is close to the existing *Cladium mariscoides* (Muhl.) Torr., but may be distinct and represent an extinct species. The former is found in marshes from Nova Scotia to Florida but has not been recorded in the flora of the District. The genus is otherwise unknown in the Pleistocene of North America, although it is not uncommon in deposits of this age in Europe.

DULICHIUM ARUNDINACEUM (L.) Britton (Pl. 1, f. 17, 18)

The achenes of this species are among the commoner remains in the swamp deposit. This species, perhaps more commonly known as *Dulichium spathaceum* (L.) Pers., is a denizen of sluggish water bordering streams and ponds, and is found at the present time from Nova Scotia to Ontario and Minnesota, and southward to Florida and Texas. It is frequent in the District, especially along the Potomac River flats. In former times, that is, during the Pleistocene, this species had a much more extended range, undoubted specimens having been found in the Pleistocene of Holland, Denmark, and Germany.[8] The genus is monotypic in eastern North America at the present time, but four species have been described from the Pliocene of Holland.

[7] Coleman, A. P., Geol. Soc. Am. Bull. **26**: 247. 1915.

[8] Stoller, J., *Über das foss. Vorkommen der Gattung Dulichium in Europa.* Jahrb. k. Preuss. geol. Landes **30**: 161. 1909 (1911).

DICOTYLEDONAE

POLYGONUM HYDROPIPEROIDES Michx. (Pl. 1, f. 19–22)

Achenes not uncommon in the swamp deposit, about 0.104 inches in length. The illustrations fail to bring out their triangular cross-section. This species is found in swamps and wet places ranging from southern Canada to Florida and Mexico, and in California. In the Flora of the District of Columbia it is recorded, under the name of *Persicaria hydropiperoides* (Michx.) Small, from several stations along the Potomac, but is not common.

Fossil forms of *Polygonum* have been recorded from the Pleistocene of Ontario,[9] Maryland,[10] and Florida.[11]

POLYGONUM sp. (Pl. 1, f. 23)

This may possibly be a variant of the preceding species, or it may represent a second species of the genus. The fact that it is represented by the single specimen figured suggests that the first supposition is most likely the correct one.

CHENOPODIUM sp. (Pl. 1, f. 24)

This large seed of a *Chenopodium* is most like those of the existing *Chenopodium hybridum* L., a form of woods and thickets found from Canada to New Mexico and in the eastern United States from New Jersey northward to Quebec. It is therefore extra-limital in the District, but this loses its significance when it is recalled that almost any of our chenopodiums might produce a few big seeds like the fossil, although most of the species recorded in the Flora of the District are naturalized weeds.

PHYTOLACCA DECANDRA L. (Pl. 1, f. 26–28)

Characteristic seeds of this species are represented by several specimens in the collection. The pokeweed is found in various situations, usually in rich moist soil, from Maine and Ontario to Minnesota and southward to Florida and Texas. It has become naturalized in Europe. Its chief interest in the present connection is the fact that the balance of the genus is tropical and this species apparently represents a northward extension of range that took place at least as early as the late Pleistocene.

CASTALIA sp. (Pl. 1, f. 25)

These seeds, which have been identified for me by W. L. McAtee, are immature seeds of an undetermined species of water-lily. The only *Castalia* in the existing flora of the District is *Castalia odorata* (Dryand.) Woodv. & Wood, the common white water-lily, and the fossil may well represent that species. The genus has not been recorded hitherto in the North American Pleistocene.

[9] Coleman, A. P., Geol. Soc. Am. Bull. **26**: 247. 1915.
[10] Hollick, A., Maryland Geol. Surv. Plio-Pleistocene 231. 1906.
[11] Berry, E. W., Journ. Geol. **25**: 662. 1917.

CERATOPHYLLUM DEMERSUM L. (Pl. 1, f. 33–35)

The hornwort fruit, which is a nut or achene, shows considerable variation in its spinelike beak (the persistent style), and in the degree to which the margin is spined or tuberculated. Several supposed species have been based upon these variations of the fruit, the fossil resembling the variety *echinatum* A. Gray. Many botanists, however, believe these differentiations to be valueless.

The plant is a submerged aquatic of ponds and slow streams, and at the present time it is found throughout all of North America except the far north. The fossil fruits are characteristic, and I have figured one 4/5's natural size, showing the beak, and two others enlarged, in which the beaks are broken away. The species is found in the District at the present time near the Potomac River from Plummers Island southward, but rarely fruiting, being generally propogated by buds. The genus is not otherwise known in the American Pleistocene.

RANUNCULUS sp. (Pl. 1, f. 29–31)

There are numerous specimens and some variety of achenes that can be rather confidently referred to this genus. They doubtless represent more than a single species, but I do not feel that they can be conclusively identified. The present flora of the District includes 12 species of *Ranunculus*. Several species have been recorded from Pleistocene deposits in Europe, where they seem to be determined with a great deal of confidence; but none are known from the American Pleistocene, although *Ranunculus aquatilis* L., has been found in what is called post-Pleistocene, at Hadley, Massachusetts.[12]

RUBUS sp. (Pl. 2, f. 1)

These characteristic seeds of some species of *Rubus* are exceedingly common in the swamp deposit. After an extended comparison with the seeds of recent species of raspberries and blackberries I have concluded that specific identification based on the seeds alone is unreliable, although several European students of fossil seeds have apparently not found this to be the case.

There are six species of *Rubus* in the existing flora of the District, and the fossil probably represents the modern *Rubus hispidus* L. which occurs in low woods, especially in the Coastal Plain. A rubus stone has been recorded from the Pleistocene of Alabama.[13] and a prickly twig from deposits of this age in North Carolina.[14]

PRUNUS SEROTINA EHRH.? (Pl. 2, f. 2, 3)

These stones, of which several specimens have been found, are small, smooth, and nearly globose. They very probably represent a Pleistocene ancestral form of the black cherry, *Prunus serotina* Ehrh., although this identification

[12] Emerson, B. K., U. S. Geol. Surv. Bull. **597**: 148. 1917.
[13] Berry, E. W., Torreya **14**: 161. 1914.
[14] Berry, E. W., Journ. Geol. **15**: 344. 1907.

is not positive. This species, in the existing flora, is a denizen of rich woods and open places from southern Ontario to Florida, and westward to the eastern prairie states. It is frequent to the existing flora of the District. The presence of these stones in the swamp deposit might be explained as having been due to water transport after drying, but their presence is much more readily explained as having been due to the droppings of birds, which normally distribute them very widely.

The genus *Prunus* is supposed to date from the Upper Cretaceous, and stones have been found in the lower Eocene of the United States.[15] Several species have been recorded from the Pleistocene of Europe, and in this country Pleistocene species are known from Ontario,[16] from cave deposits in Pennsylvania,[17] and from post-glacial beds in Massachusetts.[18]

ACALYPHA VIRGINICA L. (Pl. 2, f. 10)

This large, mostly tropical and sub-tropical genus of herbs and shrubs extends northward as far as Ontario in the case of this single herbaceous species. Characteristic seeds are present in the swamp deposit. In the modern flora this species is an inhabitant of woods and thickets ranging from Ontario to Florida, and it is common in the existing flora of the District. The genus is not known elsewhere in the fossil state.

ILEX OPACA Ait. (Pl. 2, f. 4, 5)

The seeds of this species are not uncommon in the swamp deposit. In the existing flora it is found in low moist woods from southern New England to eastern Texas, and, except in the south Atlantic states, it is almost entirely confined to the Coastal Plain. Five species of *Ilex* have been recorded from the Pleistocene of North America, the present species occurring in beds of that age in North Carolina[19] and Alabama.[20]

VITIS CORDIFOLIA Michx. (Pl. 2, f. 6–9)

Seeds of the chicken or frost grape are among the most abundant fossils in the swamp deposit, ranking next to the seeds of the bald cypress in abundance. They are frequently broken and are invariably hollow, as are most of the associated remains. They show considerable variation in size and form but are believed to represent a single species. The extremes of size are figured.

This species, which is also known as the possum and winter grape, is an inhabitant of low moist thickets and stream banks, and is found from New

[15] Berry, E. W., U. S. Geol. Surv. Prof. Paper **91**: 221, *pl. 116, f. 1.* 1916.

[16] Penhallow, D. P., Am. Nat. **41**: 448. 1907; Coleman, A. P., Geol. Soc. Am. Bull. **26**: 247. 1915.

[17] Mercer, H. C., Journ. Acad. Nat. Sci. Phila. ser. 2, **11**: 281. 1899.

[18] Emerson, B. K., U. S. Geol. Surv. Bull. **597**: 148. 1917.

[19] Berry, E. W., Journ. Geol. **15**: 345. 1907.

[20] Berry, E. W., Am. Nat. **41**: 686, *pl. 2, f. 1.* 1907.

England westward to Nebraska, and southward to Florida and Texas. It is recorded as not uncommon in the flora of the District.

Grape seeds of various species, usually unidentified specifically, are common in the Pleistocene of the Atlantic Coastal Plain, and have been recorded from New Jersey,[21] Maryland,[22] Virginia,[23] and North Carolina.[24]

AMPELOPSIS (?) sp. (Pl. 2, f. 19)

A small berry-like, pedicellate fruit, apparently two-seeded, is tentatively referred to the genus *Ampelopsis*, and may be compared with the fruits of existing *Ampelopsis cordata* Michx., a species of swamps and river banks, found at the present time from southern Virginia to Florida, and westward to Illinois, Kansas, and Texas. The fossil is too small to represent a normal fruit of *Ampelopsis arborea* (L.) Rusby, which is a native of the District at the present time. Its identification is too uncertain to be considered as of special significance.

CORNUS AMOMUM Mill. (Pl. 2, f. 15–18)

The silky cornel, swamp dogwood, or kinnikinnik, is a shrub of low woods and stream banks, which, at the present time, ranges from New Brunswick and Ontario westward to Dakota and Nebraska, and southward to Florida and Texas. It is not at all uncommon in the modern flora of the District.

The stones of this species are not uncommon in the swamp deposit. They are usually somewhat compressed, pointed at both ends, unsymmetrical in outline, and irregularly ridged. Specimens are figured showing lateral and vertical views, as well as in section showing the two cells.

Stones belong to different species of the genus *Cornus* are not uncommon in the Pleistocene of Europe. In deposits of this age in North America the only previous record is in the Pleistocene of New Jersey.[25]

LEUCOTHOË RACEMOSA (L.) A. Gray (Pl. 2, f. 11–14)

This species, which is new to the Pleistocene of North America, is represented in the swamp deposit by the single depressed-globose, 5-valved capsule figured, and by numerous detached loculicidal valves, some of which are figured from different angles.

The swamp leucothoë is usually found in swamps and moist thickets, although it may also occur in drier situations. It is found from Massachusetts to Florida and Louisiana at the present time, and is usually restricted to localities in the Coastal Plain. It is recorded, under the name of *Eubotrys racemosa* (L.) Nutt., as frequent, in the flora of the District of Columbia.

[21] Berry, E. W., Torreya **10**: 266. 1910.
[22] Hollick, A., Maryland Geol. Surv. Pleistocene 235. 1906.
[23] Berry, E. W., Torreya **6**: 89. 1906.
[24] Berry, E. W., Journ. Geol. **15**: 345. 1907.
[25] Penhallow, D. P., Trans. Roy. Soc. Canada, ser. 2, sec. **4**: 70. 1896.

GALIUM sp. (Pl. 2, f. 20)

With the exception that the two specimens collected have an aperture at both poles, they are very similar to the fruits of various species of *Galium*. Since the embryo in Galium seeds is at the pole this region would probably be one to decay more rapidly, which might account for the double opening. Specific identification is impossible, but the specimens suggest the Holarctic recent species *Galium triflorum* Michx., which, in the existing flora of North America, is a woodland species, ranging from Nova Scotia to Alaska, and southward to California, Louisiana, and Alabama. It is common in damp woods in the existing flora of the District of Columbia, in which seven other species of *Galium* are also reported. *Galium* has been recorded from the European Pleistocene, but has not been found heretofore in deposits of that age in America.

SAMBUCUS CANADENSIS L. (Pl. 2, f. 21–24)

The one-seeded, rough-surfaced nutlets of this species are rather common in the swamp deposit. The elder, or as it is more commonly termed, the elder-berry, inhabits wet situations generally thickets, and at the present time ranges from Nova Scotia westward to Manitoba and Kansas, and southward to Florida and Texas. It is still abundant in the District of Columbia. The genus has not been known before in the American Pleistocene.

VIBURNUM NUDUM L. ? (Pl. 2, f. 25)

The specimen is a stone apparently belonging to this species, which, in the existing flora, is a rather large shrub of swamps, ranging from Long Island to Florida, and westward to Kentucky and Louisiana. It is common in swampy and wet places in the present flora of the District. This species has been reported from the Pleistocene of North Carolina[26] and Florida.[27]

VIBURNUM sp. (Pl. 2, f. 30)

This flattened equilateral stone is typical of certain species of *Viburnum* and probably represents the modern species *Viburnum prunifolium* L., which, in the existing flora, is a shrub or small tree, ranging from Connecticut to Florida. If this is the correct affinity of the fossil it may be an example of a dry-soil element otherwise unrepresented in this deposit, although the black haw is not especially restricted in its habitat and is found in a variety of situations. It is common in the existing flora of the District. In the absence of certainty of identification it would be futile to discuss the meaning of its presence in the present assemblage. It has not before been found fossil, although the stones of several other species of *Viburnum* have been found in the Pleistocene of the United States.

[26] Berry, E. W., Torreya **14**: 160. 1914.
[27] Berry, E. W., Journ. Geol. **25**: 662. 1917.

Additional plant remains which are shown on the accompanying plates, and which are not positively determined, comprise the following:

1. A characteristic prickle, evidently of some species of *Rubus* or *Rosa* (Pl. 2, f. 27).

2. Fruits that appear to represent some undetermined species of the family Ranunculaceae (Pl. 2, f. 26).

3. Immature fruits of the genus *Ranunculus* (Pl. 1, f. 32; pl. 2, f. 28).

4. Immature fruits of sedges, probably representing the genera *Carex* and *Scirpus* (Pl. 2, f. 31).

HEXAPODA-DIPTERA

RETINODIPLOSIS sp. (Pl. 2, f. 32–34)

These galls are very abundant in the swamp deposit. They are roughly spherical, thick walled, monothalamous, about 5 mm. in diameter. Dr. E. P. Felt, the well known authority on galls, has kindly examined them and states that they belong to the genus *Retinodiplosis* Kieff, of the family Itonididae—the gall midges.

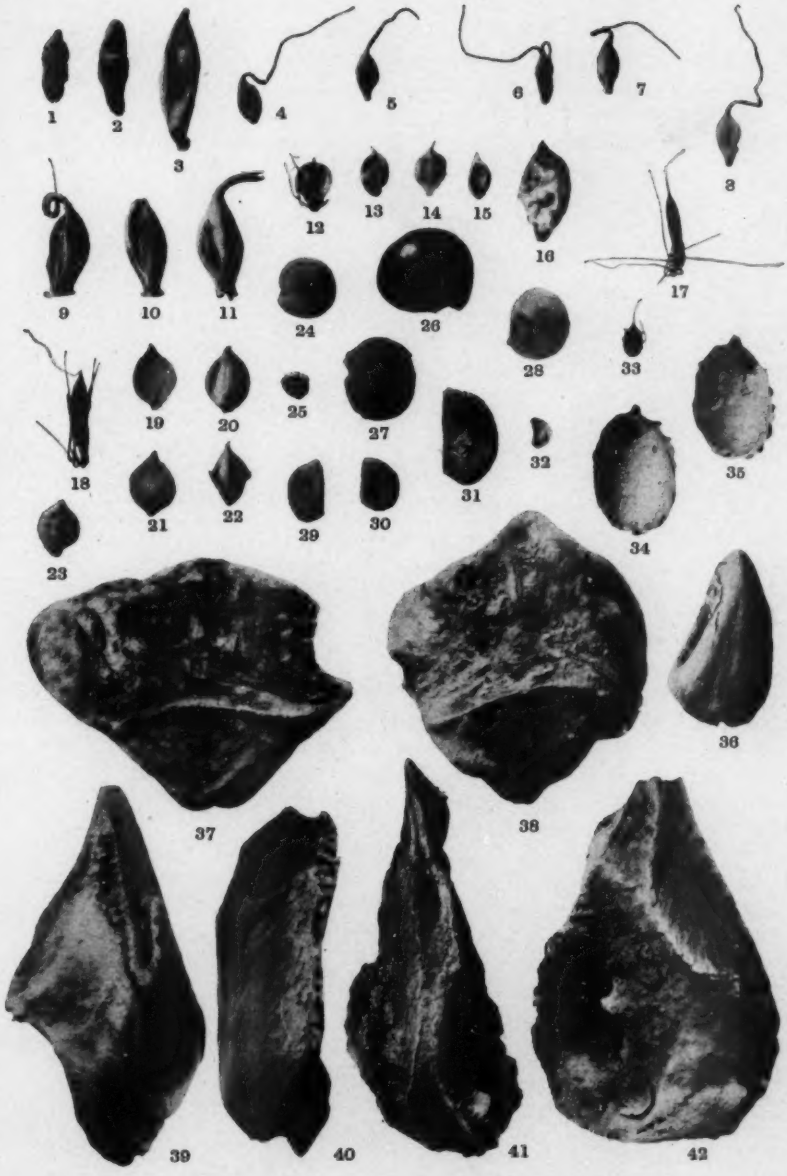
Although possibly specifically distinct they are very close to the species *Retinodiplosis taxodii* Felt,[28] whose galls are tightly packed in the cones of the cypress and probably represent modified or aborted seeds. Dr. Felt considers this cypress midge as decidedly more primitive than the other species of the genus occurring in the pines.

ITONIDA sp. (Pl. 2, f. 29)

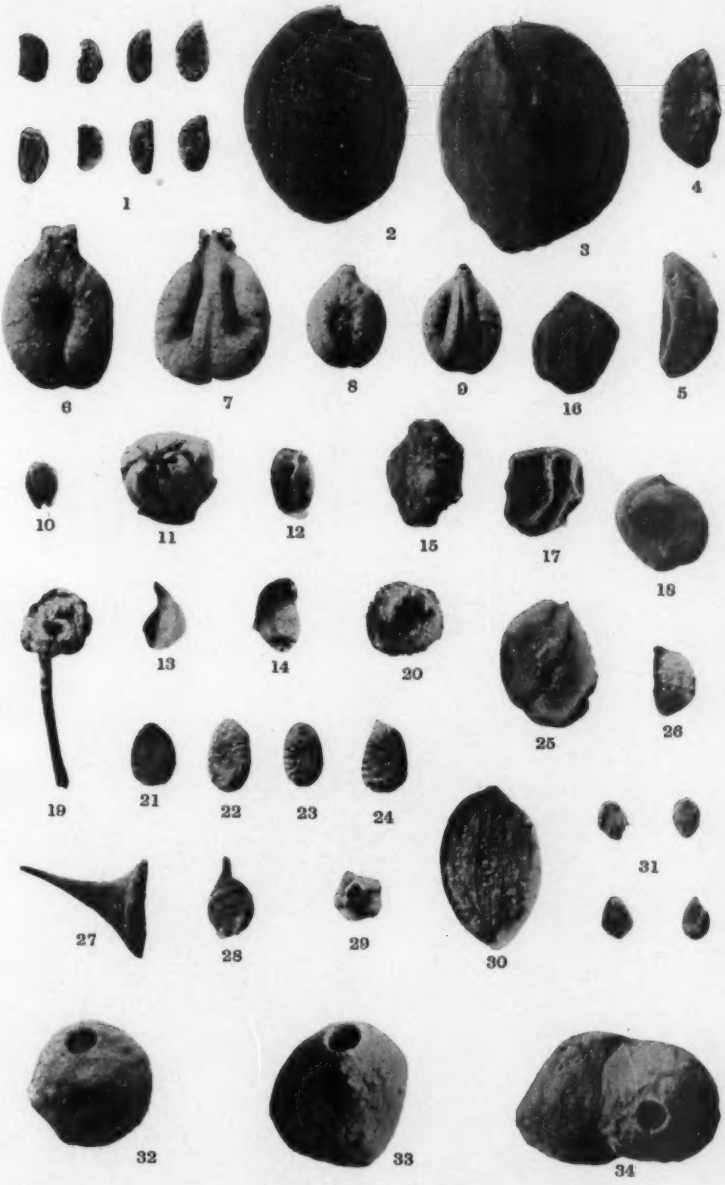
These galls are small, rotately 5-lobed and stalked. Several specimens have been found in the swamp deposit, but they are much less abundant than the *Retinodiplosis* galls. They were examined for me by W. L. McAtee who, however, is not responsible for the generic name. The genus *Itonida* belongs to the same family as *Retinodiplosis*, and is a more modern name for the well known term *Cecidomyia*.

The fossil galls are very close to the galls of *Itonida anthici* Felt,[29] and very probably represent that species. The latter are flower-like, and are borne on the leaves of the bald cypress. For their general appearance in life the reader is referred to an illustration published by Dr. Felt.[30]

[28] Felt, E. P., Ent. News **27**: 415–417. 1916.
[29] Felt, E. P., Econ. Ent. Journ. **6**: 278. 1913.
[30] N. Y. State Mus. Bull. pp. 231–232. 1920.



BERRY ON ORGANIC REMAINS



BERRY ON ORGANIC REMAINS

BERRY ON ORGANIC REMAINS

PLATE 1

Figs. 1–3. *Naias* sp.
Figs. 4–8. *Carex* cf. *collinsii* Nutt.
Figs. 9–11. *Carex* cf. *intumescens* Rudge.
Fig. 12. *Scirpus* cf. *lacustris* L.
Figs. 13–15. *Scirpus* cf. *americanus* Pers.
Fig. 16. *Cladium* sp.
Figs. 17, 18. *Dulichium arundinaceum* (L.) Britton.
Figs. 19–22. *Polygonum hydropiperoides* Michx.
Fig. 23. *Polygonum* sp.
Fig. 24. *Chenopodium* sp.
Fig. 25. *Castalia* sp., immature.
Figs. 26–28. *Phytolacca decandra* L.
Figs. 29–31. *Ranunculus* sp.
Fig. 32. *Ranunculus* sp., immature.
Figs. 33–35. *Ceratophyllum demersum* L.
Fig. 36. *Sparganium eurycarpum* Engelm.
Figs. 37–42. *Taxodium distichum* (L.) Rich., cone scales and seeds.

All of the figures on this plate are from untouched photographs and all are uniformly enlarged four times natural size except Figure 33 which is $\frac{4}{5}$ natural size.

PLATE 2

Fig. 1. *Rubus* sp., eight stones.
Figs. 2, 3. *Prunus serotina* Ehrh. (?), 2 stones.
Figs. 4, 5. *Ilex opaca* Ait.
Figs. 6–9. *Vitis cordifolia* Michx. showing maximum and minimum sozed seeds.
Fig. 10. *Acalypha virginica* L.
Figs. 11–14. *Leucothoë racemosa* (L.) A. Gray. Fig. 11 shows a complete capsule, and Figs. 12–14 show detached valves, the usual method of occurrence.
Figs. 15–18. *Cornus amomum* Mill., various stones. Fig. 17 shows one in cross-section.
Fig. 19. *Ampelopsis* (?) sp.
Fig. 20. *Galium* sp.
Figs. 21–24. *Sambucus canadensis* L.
Fig. 25. *Viburnum nudum* L. (?)
Fig. 26. Fruit of some member of the Ranunculaceae.
Fig. 27. Thorn of *Rubus* or *Rosa*.
Fig. 28. *Ranunculus* sp., immature.
Fig. 29. *Itonida* sp., Gall of cypress leaf midge viewed from above.
Fig. 30. *Viburnum* sp., probably prunifolium L.
Fig. 31. Fruits of sedges, immature.
Figs. 32–34. *Retinodiplosis* sp., cypress cone galls.

All of the figures on this plate are from untouched photographs and all are uniformly enlarged four times natural size.

PLATE 3

Fig. 1. Cross-section of cypress log.
Fig. 2. Longitudinal section of cypress knee.

DIATOM DEPOSIT FOUND IN THE EXCAVATION

ALBERT MANN, NATIONAL MUSEUM

In making the excavations under discussion it was found necessary to dig down to bed-rock, as building operations in the vicinity had shown the locality to be swampy and a stream to have had its bed nearby. The site had been filled in by the city. To reach a solid foundation digging was carried to a depth of 35 to 40 feet below the level of the adjacent streets. Close to the bottom of the excavation a swamp-like deposit was uncovered, in which were embedded the stumps of large bald cypress trees (*Taxodium distichum*) in a fair state of preservation. The soil in which they had flourished was dark gray, almost black, and of a decidedly peaty texture, and was found to be richly mixed with the silica remains of fresh water diatoms. The material having been cleaned, the diatom flora proves so unique that a report seems to be called for.

In all, 78 species and notable varieties of diatoms have been detected in this deposit, which is rather more than the number of species usually found in fresh water localities in and about Washington at the present time. A large proportion of these are now locally unrepresented. In fact, so many are very rare and unique that one may be led to infer either that their life-period dates back very many years and that the deposit is a sub-fossil one, or that they flourished under quite different conditions from those of the present time. Their antiquity is further suggested by the fact that many of the specimens are in a decayed or "rotten" condition, indicating that they have been subjected for a long time to some corrosive agency. This is especially noticeable in those species that have thin and delicate "frustules," the technical name given to the silica boxes or encasements that surround the life-substance of diatoms. Since silica, the material composing these diatom boxes, is affected only by hydrofluoric acid and by alkaline solutions, the corrosion here noted must have required a great many years. A weak solution of potash, soda, or lime, such as is generally found in alkaline soils, has only a very feeble and slow effect as a silica solvent. It may be added that there are rather an unusual number of distorted and misshapen diatoms present, and that this distortion is rather common where these microscopic plants are forced to grow in alkaline waters, especially if lime is present.

Another fact suggestive of the age of this deposit is that a number of uncommon species found here are characteristic of certain fossil diatom beds located in central Alabama, notably at Montgomery. In the Alabama State Geological Survey for 1894 is a report by K. N. Cunningham on the fossil diatoms of Montgomery, the geological age of which has been fixed as Pleistocene. Material from this precise spot is now not procurable, because the city has extended over the most of the diatom bed. But samples obtained from outcrops locted in the suburbs of the city have been examined and these agree in general with the Cunningham report. He lists 55 species, of which 44, or 80 per cent, have been found in the Connecticut avenue deposit. Of the 11 not found there nearly all are very minute forms, which may have escaped discovery in the examination of the local material. It should be noted that the close resemblance between these two deposits is seen not so much in the number of species common to both as in the rarity of many of the species common to both; and it must be recognized as a significant fact that the diatoms of the two beds—one Pleistocene fossil at Montgomery, Alabama, and the other here at Washington—are strikingly like each other and quite unlike the usual diatoms now found in a living state in the two localities.

To confirm this last point I have examined the diatom flora of a bald cypress swamp near Cape Henry, Virginia. A few of the species found therein are present in the Connecticut avenue material; but they represent only such cosmopolitan species as inevitably are looked for in any fresh-water growths, fossil or recent, occurring in this part of the world. This correspondence therefore has little significance, especially as these recent cypress-swamp diatoms do not include a single one of the rare and unusual species found in the local material, in the Pleistocene material from Montgomery, and in some supposedly fossil material from Crane Pond, Massachusetts, the peculiarities of which will be hereafter noted. In other words, the diatoms of the local swamp are strikingly like those of the two fossil deposits and strikingly unlike those of the near-by bald cypress swamp now growing under practically identical conditions.

The remarkable similarity between a diatom flora found at Crane Pond, Massachusetts and this local flora is worthy of further attention. At the time that material was distributed to diatom students, it was understood to have been obtained from a stratum 13 feet below the mud surface of the bottom of the pond, although I am unable to find any reference in diatom literature to confirm this. At any rate, no

considerable number of the Crane Pond species have been met with elsewhere until they appear in this Connecticut avenue excavation In other words, most of the species common to Crane Pond and to the Connecticut avenue deposit are rare, and even when discovered at other localities are always commented upon as unusual. Thus, a few are recorded from French's Pond, Albany, Maine; from Wolfboro, on Lake Winnepesaukee, New Hampshire; from Waltham, Massachusetts; and, strangest of all, from the Demerara River in British Guiana. But the parallel existing between any of these is far less striking than that between Crane Pond and this local deposit.

Of the 78 species and well-marked varieties found in the local deposit 64, or over 80 per cent, belong also to the Crane Pond diatom flora. In the appended list the species common to both localities are marked with an asterisk. The parallel here shown is so close that it is fair to assume that the two floras would be found to be even more, rather than less, alike if an exhaustive study supplied us with complete lists from both places.

One of the rare species frequent in the Connecticut avenue material brings out an interesting fact. It is called *Navicula Schinzii* Br. It was first discovered in two fresh water lakes in West Africa, Olukonda and Ombika, and was subsequently discovered in the fossil material at Montgomery, Alabama. To rediscover this very rare diatom so far away from its first place of discovery is interesting, and to find that it seems to have developed nowhere in this country except in the Pleistocene deposit at Montgomery and in this bald cypress swamp in Washington is even more so. It certainly strengthens the belief that this local swamp dates back in its origin a great many years.

It may be well to summarize the three points of special interest in this study: (1) There is a great dissimilarity between the present-day local diatom flora, including that of near-by bald cypress swamps, and the diatom flora of the Connecticut avenue deposit; (2) there is a striking similarity between the diatoms of the local deposit and those found in the supposedly fossil material from Crane Pond, Massachusetts, and in the fossil bed at Montgomery, Alabama (3) there is an indication of the antiquity of this deposit shown by the decayed condition of many of the specimens, suggestive of long subjection to the corrosive effect of alkaline waters. The writer's knowledge of Geology is too superficial to warrant any conclusion as to the precise age of this deposit, based on a study of its diatoms. But it can

be safely stated that in view of this study the burden of proof must rest on anyone who claims that this swamp is one of recent origin.

LIST OF SPECIES[1]

AMPHORA PROTEUS Greg.* Sch. At. *pl. 27, f. 4, 7.*
COCCONEIS PLACENTULA E.* Sch. At. *pl. 192, f. 45.*
COCCONEIS PLACENTULA var.*
CYMATOPLEURA ELLIPTICA (Breb.) W. S. V. H. Syn. *pl. 53, f. 1–4.*
CYMBELLA AMERICANA A. S.* Sch. At. *pl. 9, f. 15, 20.*
CYMBELLA AMERICANA var. ACUTA* Sch. At. *pl. 71, f. 75–78.*

This is one of the forms which is also reported from the Demerara River, British Guiana. No other locality is given, but it occurs here and in Crane Pond.

CYMBELLA EHRENBERGII K.* V. H. Syn. *pl. 2, f. 1.*
CYMBELLA GASTROIDES K.* V. H. Syn. *pl. 2, f. 8.*
CYMBELLA LANCEOLATA E.* V. H. Syn. *pl. 2, f. 7.*
CYMBELLA LUNULA (E.) Rab.* Sch. At. *pl. 71, f. 33;* V. H. Syn. *pl. 3, f. 16A.*
EPITHEMIA ARGUS (E.) K. V. H. Syn. *pl. 31, f. 151.*
EPITHEMIA ARGUS var. AMPHICEPHALA Grun.* V. H. Syn. *pl. 31, f. 19.*
EPITHEMIA GIBBA (E.) K.* V. H. Syn. *pl. 32, f. 5.*
EPITHEMIA GIBBA var. VENTRICOSA Grun.* V. H. Syn. *pl. 32, f. 4, 5.*
EPITHEMIA TURGIDA (E.) K.* V. H. Syn. *pl. 31, f. 1, 2.*
EUNOTIA FORMICA E. V. H. Syn. *pl. 34, f. 1.*
EUNOTIA GRACILIS (E.) Rab.* V. H. Syn. *pl. 33, f. 1, 2.*
EUNOTIA MINOR (K.) Rab.* V. H. Syn. *pl. 33, f. 20, 21.*
EUNOTIA MONODON E.* V. H. Syn. *pl. 33, f. 3.*
EUNOTIA PECTINALIS (K.) Rab.* type. V. H. Syn. *pl. 33, f. 16.*
EUNOTIA PECTINALIS var. UNDULATA Ralfs.* V. H. Syn. *pl. 33, f. 17.*

Not only the type form of this species is found here but a curious variety called var. *undulata.* It was named "Himantidium undulatum" in S. B. D. 2: 12, *pl. 33, f. 281a,*[2] and an excellent figure of the precise form common to both the Crane Pond and the Connecticut avenue

[1] The references included are to satisfactory illustrations in diatom literature. The abbreviations used are as follows:

Authors: Ag. = Agardh; A. S. = Adolph Schmidt; Br. = Brun; Cl. = Cleve; E. = Ehrenberg; Greg. = Gregory; Grun. = Grunow; Hantz. = Hantzsch; H. Heid. = H. Heiden; K. = Kutzing; Rab. = Rabenhorst; W. S. = William Smith; V. H. = Van Heurck.

Books: Cl. Nav. Diat. = CLEVE: *Naviculoid diatoms.*
Cl. & Grun. Arct. Diat. = CLEVE & GRUNOW: *Arctic diatoms.*
Espec. Nouv. = BRUN: *Especes nouvelles.*
H. L. S. Types = H. L. SMITH: *Diatomacearum species typicae.*
Mic. Jour. = Monthly Microscopical Journal, London.
Per. Mono. = H. PERAGALLO: *Monographie du genre Pleurosigma.*
S. B. D. = WILLIAM SMITH: *British diatoms.*
Sch. At. = *Schmidt's Atlas der Diatomaceen*-Kunde.
V. H. Syn. = VAN HEURCK: *Synopsis des diatomees de Belgique.*
W. & C. N. & R. Diat. = WALKER & CHASE: *New and rare diatoms.*

deposits is given in Lewis, White Mt. Diat. *pl. 2, f. 13a.* The similarity between these two diatom floras is especially emphasized by this form, because the peculiarities of modification are therein duplicated to the minutest detail.

EUNOTIA ROBUSTA (E.) Ralfs.* V. H. Syn. *pl. 33, f. 12.*

GOMPHONEMA ACUMINATUM E.* V. H. Syn. *pl. 23, f. 15, 16.*

GOMPHONEMA GRACILE E.* Sch. At. *pl. 236, f. 16.*

GOMPHONEMA GRACILE var. LANCEOLATA E. Sch. At. *pl. 236, f. 26.*

GOMPHONEMA SUBTILE E. Sch. At. *pl. 236, f. 10;* V. H. Syn. *pl. 23, f. 13.*

MELOSIRA DISTANS (E.) K.* V. H. Syn. *pl. 86, f. 21, 28.*

MELOSIRA LAEVIS (E.) Grun. V. H. Syn. *pl. 88, f. 191,* misnamed in Sch. At. *pl. 182, f. 36 M. Roeseana* Rab.

NAVICULA ACROSPHAERIA var. LAEVIS Breb. Sch. At. *pl. 43, f. 18.*

NAVICULA AFFINIS E. var.* Sch. At. *pl. 49, f. 1.*

NAVICULA AMERICANA E.* V. H. Syn. *pl. 12, f. 37.*

NAVICULA AMERICANA narrow var. Sch. At. *pl. 312, f. 14.*

NAVICULA AMPHIRHYNCHUS E.* Sch. At. *pl. 49, f. 27–29.*

NAVICULA APPENDICULATA (Ag.) K.* V. H. Syn. *pl. 6, f. 18, 19.*

NAVICULA BACILLUM E.* V. H. Syn. *pl. 13, f. 8;* Cl. & Grun. Arct. *pl. 2, f. 50.*

Navicula bihastata Mann, nom. nov.* Pl. 4, f. 2; see also Cl. Nav. Diat. 2:88, *pl. 1, f. 21.*

This has been called *Pinnularia trigonocephala* by Cleve (Nav. Diat. 2:88, *pl. 1, f. 21),* where there is a good illustration. The restoration of the indistinct genus *Pinnularia* not being advisable, and *Navicula trigonocephala* being preempted by Ralfs, I find it necessary to assign to it a new name. This is quite a rare species.

NAVICULA CARDINALICULUS (Cl.) Mann, Cl. Nav. Diat. 2:79, *pl. 1, f. 12a.* Cleve says that this is found in Crane Pond, Massachusetts; French's Pond, Albany, Maine; and Houghton, Michigan.

Navicula cuneicephala Mann, nom. nov.* Pl. 4, f. 5; see also Sch. At. *pl. 43, f. 19.*

My form agrees closely with the illustration in Schmidt's Atlas; but, as in the case of *N. bihastata,* I cannot use the specific name already given because of *N. integra* W. S.

NAVICULA CUSPIDATA K.* V. H. Syn. *pl. 12, f. 4.*

All the specimens of this species found at Crane Pond and in the local deposit are peculiar in being narrowed at either end into an elongated tip. The type form, which is common throughout this part of the world at the present time, is much more truly spindle-shaped.

NAVICULA DACTYLUS (E.) K.* V. H. Syn. *pl. 5, f. 1;* Sch. At. *pl. 42, f. 6.*

NAVICULA ELLIPTICA K.* H. L. Sm. Types *pl. 271.*

NAVICULA EXIGUA Greg.* V. H. Syn. *pl. 8, f. 32;* Mic. Journ. 1854: *pl. 4, f. 14.*

It is possible this species is a variety of *N. Gastrum.*

NAVICULA FLEXUOSA Cl.* Nav. Diat. 2:93, *pl. 1, f. 23.*

This species was found originally in Crane Pond, and forms found here and in that material are identical. It is possible that this species is invalid and should be looked upon as a variety of *N. Dactylus.*

NAVICULA GIBBA (E.) var.* Sch. At. *pl. 45, f. 48.*

NAVICULA INSTABILIS A. S.* Sch. At. *pl. 43, f. 36.*

NAVICULA INSTABILIS A. S. var.* Sch. At. *pl. 43, f. 37.*

There are two well-marked forms of this species, corresponding to the figures given.

NAVICULA IRIDIS E. var.* Sch At. *pl. 49, f. 2, 4.*

NAVICULA LEGUMEN (E.) A. S.* Sch. At. *pl. 44, f. 44–47.*

NAVICULA LIMOSA K.* V. H. Syn. *pl. 12, f. 18–21.*

Perhaps a variety of *N. gibberula* K.

NAVICULA MAJOR K. Typical.* Sch. At. *pl. 42, f. 8.*

NAVICULA MESOLEPTA var. STAURONEIFORMIS (E.) Grun.* Sch. At. *pl. 45, f. 52, 53.*

NAVICULA NOBILIS (E.) K.* Sch. At. *pl. 43, f. 1.*

NAVICULA PERIPUNCTATA Br.* Expec. Nouv. p. 37, *pl. 16, f. 11;* also Sch. At. *pl. 311, f. 5–7,* misnamed.

Schmidt, in the reference above given, confuses this with the very different *N. Formica* E. So far as I know, this delicate species has never been found, except at Crane Pond, until discovered here.

NAVICULA PRODUCTA W. S.* S. B. D. *pl. 17, f. 144;* Sch. At. *pl. 49, f. 38.*

NAVICULA PRODUCTA var.* Sch. At. *pl. 49, f. 40,* unnamed.

NAVICULA RUPESTRIS (Hantz) A. S.* Sch. At. *pl. 45, f. 43.*

Perhaps this is a variety of *N. commutata* Grun., as figured in Sch. At. *pl. 45, f. 37.*

NAVICULA SCHINZII Br. Pl. 4, f. 4; see also Sch. At. *pl. 242, f. 9.*

The presence of this diatom in this gathering, found originally in west Africa and subsequently in a fossil bed in Alabama, has been already discussed.

NAVICULA SILLIMANORUM (E.) K.* Lewis, White Mt. Diat. *pl. 2, f. 8;* W. & C. N. & R. Diat. *pl. 2, f. 2.*

NAVICULA SUBACUTA A. S.* Sch. At. *pl. 42, f. 8,* passing into the next.

NAVICULA VIRIDIS (Nitz.) K.

NAVICULA SUBCAPITATA (Greg.) V. H. Sch. At. *pl. 44, f. 53, 55;* V. H. Syn. *pl. 6, f. 22.*

NAVICULA SUBOVALIS (Cl.) Mann.* Nav. Diat. 1:96, *pl. 1, f. 27.* Pl. 4, f. 4.

This diatom, called by Cleve *Diploneis subovalis,* was found in fresh water material from New Zealand. It closely resembles *N. elliptica* K. in shape and size, but has the markings of *N. Smithii* Breb. I have found rare specimens of it in several fresh water gatherings; and as *N. Smithii* is a marine form, I have hitherto considered it as an adaptation of that species to fresh water conditions. It is interesting to note that it is a common form in Crane Pond.

NAVICULA TABELLARIA (E.) K.* V. H. Syn. *pl. 6, f. 8.*

Navicula torta Mann, nom. nov.* Pl. 4, f. 6.

This diatom is well illustrated by Cleve (Nav. Diat. 2: *pl. 1, f. 22*) but misnamed as a variety of *N. major* K. (*N. major* var. *asymmetrica*). It has nothing to do with *N. major* but more nearly resembles *N. Trevelyana* Donk., but it should be recognized as an independent species. It is quite constant, although found in such widely distributed localities as Canada, Waltham and Crane Pond, Massachusetts, and fossil deposits at Montgomery, Alabama.

NAVICULA TRANSVERSA A. S.* Sch. At. *pl. 43, f. 56.*

NAVICULA TRINODIS W. S. Lewis, Diat. U. S. Seaboard *pl. 2, f. 6.*

The local examples of this very small and oddly shaped diatom have more rounded ends than illustrations generally give, but there is no question of its belonging to this species.

NAVICULA VIRIDIS K.* Sch. At. *pl. 42, f. 3.*
NITZSCHIA HEUFLERIANA Grun. V. H. Syn. *pl. 68, f. 13, 14.*
NITZSCHIA SPECTABILIS (E.) Ralfs.* V. H. Syn. *pl. 67, f. 8(?).*
NITZSCHIA TRYBLIONELLA Hantz var. LEVIDENSIS (W. S.) Grun. V. H. Syn. *pl. 57, f. 17.*
PLEUROSIGMA SPENCERII W. S. Per. Mono. *pl. 8, f. 20, 21.*
STAURONEIS ACUTA W. S.* V. H. Syn. *pl. 4, f. 3.*

This and the other species here classified under this generic name are unquestionably members of the genus *Navicula*. The utterly untrustworthy distinguishing mark, the stauros, appears so frequently in species that can not be classed in the same genus that any hope of a definite description is impossible. The subject is discussed at length in my *Report on the diatoms of the Albatross voyages.* I use the above generic name here because it has strongly entrenched itself in literature and will aid in understanding the references given.

STAURONEIS ALABAMAE H. Heid.* Sch. At. *pl. 242, f. 4,* var.
STAURONEIS ANCEPS E.* Sch. At. *pl. 242, f. 7,* passing into the next.
STAURONEIS PHOENICENTERON E.* V. H. Syn. *pl. 4, f. 2.*

Stauroneis Washingtonia Mann, sp. nov. Pl. 4, f. 3 and 7.

Valve narrow-lanceolate, with nearly straight sides, tapering from the center to the rounded apices; stauros narrow but not linear, not spreading, reaching to the sides; longitudinal median area evident on each side of the strong raphe, the ends of which are well separated at the center; markings, rows of beaded lines, all strongly oblique, and unusually coarse for the size of the diatom.

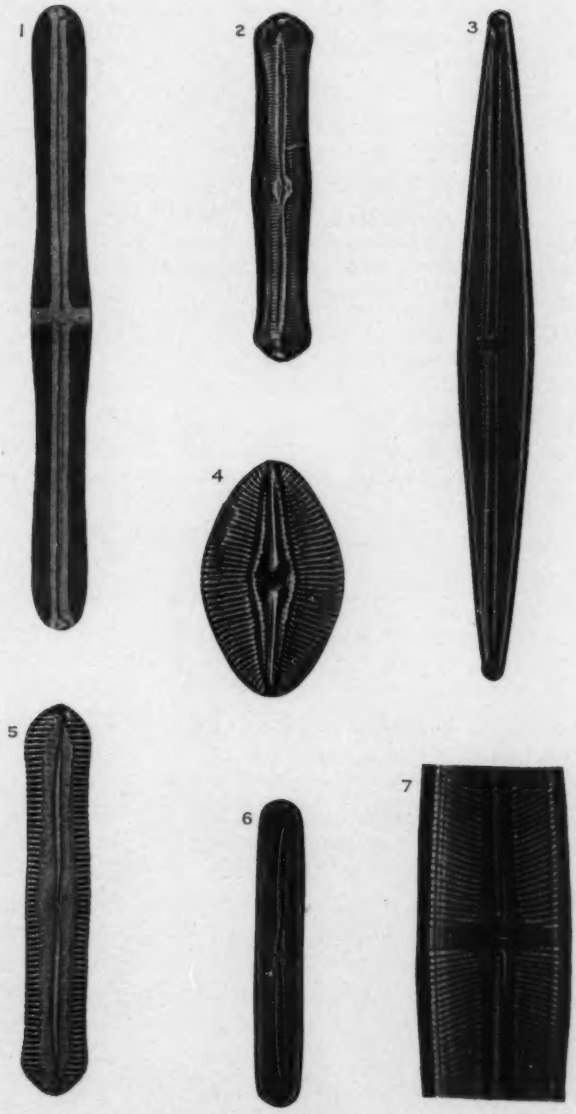
Length, 0.163 to 0.194; width, 0.020 to 0.022; 11 to 12 lines in 0.01 mm.

This does not seem to occur in the Crane Pond material, nor is there any figure closely resembling it in diatom literature. A species somewhat similar in shape is *S. Spicula* Dickie, a good figure of which is in V. H. Syn. *pl, 4, f. 9.* But that is a marine form, with very fine rectilinear markings, 28 to 29 in 0.01 mm., and with a delicate linear stauros. The lines of the present species are very coarse, even coarser than those of the much larger *S. Phoenicenteron,* which has 14 or more in 0.01 mm. It is common in the local deposit.

SURIRELLA ENGLERI O. Moller,* Sch. At. *pl. 245, f. 13–18.*
SURIRELLA TENERA Greg.* Sch. At. *pl. 23, f. 4–9.*
SURIRELLA TENERA wide var.* Sch. At. *pl. 23, f. 17.*

PLATE 4

Fig. 1, *Navicula Schinzii* Br.; 2, *Navicula bihastata* Mann, nom. nov.; 3, *Stauroneis Washingtonia* Mann, sp. nov.; 4, *Navicula subovalis* (Cl.) Mann; 5, *Navicula cuneicephala* Mann, nom. nov.; 6, *Navicula torta* Mann, nom. nov.; 7, *Stauroneis Washingtonia* Mann, sp. nov. (detail of fig. 3).



MANN ON DIATOMS

THE GEOGRAPHIC AND HISTORICAL EVIDENCE

LAURENCE LAFORGE, GEOLOGICAL SURVEY

INTRODUCTION

The problems of the origin, structural relations, and age of the muck bed containing the cypress stumps are essentially geologic, are not especially difficult, and require only ordinary geologic methods for their solution. The geologists who investigated the deposit recognized these facts and employed such methods, with the result that the evidence so obtained was abundant, plain, and unmistakable and enabled them to establish beyond question and by geologic methods alone that the muck bed is of great antiquity, humanly speaking, and that its age must be reckoned in tens of thousands of years. All geologists who examined the locality were agreed in this conclusion. Nevertheless many other persons, not appreciating the nature of the geological evidence and the certainty of the conclusions derived from it, and impressed by the nearly perfect preservation of the wood of the stumps, were skeptical of the age assigned by the geologists and preferred to regard the deposit as not more than a few score of years old.

This conclusion appeared to them to be supported by the topography of the locality and by its recent history. From Sixteenth street westward to New Hampshire avenue, L street lies in a depression which, within the memory of many old residents of Washington, was deeper than now and was the lower valley of a small stream named Slash Run—a tributary of Rock Creek. The boys and young men of 60 or more years ago caught frogs and small fish in this stream, swam in its deeper pools, and hunted rabbits and wild fowl in the reeds and brush along its banks. When the streets of that part of the city were graded a trunk sewer was built to carry the water of Slash Run and its channel was filled in, as was the adjacent low ground, in some places to a depth of 10 or 12 feet. The square bounded by De Sales, Seventeenth, and L streets and Connecticut avenue became the grounds of the Academy of the Visitation, and the building of the Academy was erected on the west end of the lot. Its north end, which was within the present hotel site, stood on filled ground over the former course of Slash Run. This building was razed several years ago and its cellar filled in.

In 1922, when the muck bed and cypress stumps were exposed in the excavation for the hotel and the geologists had announced their conclusion regarding the age of the deposit, many persons, who remembered or had heard of Slash Run and that considerable filling

had been done along its former course, hastily concluded that the plant remains were merely those of trees and other vegetation that had grown there since the settlement of the city and had been buried but a few years. In support of this contention speeches were made in meetings of local societies and letters were written to local papers, and at least one article was written by a scientific man and published in a periodical of national circulation. The arguments of all who supported this view were deficient in that they were based on oral traditions, boyhood recollections, and similar hear-say evidence and not on authenticated documentary records. Many of the arguments were also quite irrelevant and most of them completely disregarded the facts that were plainly revealed in the excavation. Hence it seemed to be desirable, to convince others of the soundness of the geologic conclusions, for the geologists to reinforce the evidence from the facts displayed in the excavation with the available geographic and historical evidence. Such evidence, on investigation, proved to be as abundant, unequivocal, and convincing as the geologic evidence and to be in entire agreement with it.

HISTORICAL EVIDENCE

The historical evidence is largely negative, that is, it is not so much directly confirmatory of the conclusions of the geologists regarding the age of the deposit as it is opposed to the conclusions of those advocating the other view. There is much historical evidence about Slash Run, the topography of its valley, and the conditions along its course, but none of any swamp along it below Massachusetts avenue, although there may have been marshy ground along the left bank of the stream in the neighborhood of Sixteenth and L streets, and along the right bank at Connecticut avenue and again between Nineteenth and Twentieth streets. In this lower part of its course the stream was mainly clear and flowed over a sandy or gravelly bed between banks 5 to 8 feet high and a few yards apart. The swimming-holes remembered by so many persons were probably partly artificial, as one of the old residents of the city has stated that such holes were dug in the bed of the stream for the use of soldiers camped in the city during the Civil War.

The stumps found in the muck bed are those of bald cypress, and the great number of stumps and the abundance of cypress leaves and seeds in the muck leave no room for doubt that the bed is the remains of a former cypress swamp. Bald cypress does not now grow naturally

in the District of Columbia nor within several miles of its boundaries and the nearest cypress swamp is in southern Maryland, about 100 miles south of Washington. There is no record of bald cypress having been found growing naturally in the District since the first visits by white men. It is not mentioned in the earliest check lists of the plants of the District, which were compiled more than a century ago, nor in any lists except those of very recent years which cover a considerable territory outside the District. Of those old residents of the city who remember playing along the banks of Slash Run in their youth, and some of whom insist that the stumps found in the excavation are those of trees growing there only 60 years ago, not one professes any recollection of a cypress swamp or of cypress trees or stumps in that locality. In a description, published in 1861, of the part of the city traversed by Slash Run, sweetgum, maple, and magnolia are enumerated as growing in or about the wetter places, but no mention is made of bald cypress. These facts alone ought to be sufficient evidence that the deposit is not the remains of a swamp that existed on the surface within the memory of men still living.

Furthermore, early records and descriptions of Washington contain several references to the finding of logs and pieces of trees, some of them nearly perfectly preserved, in digging cellars and wells during the settlement of the city, but there is no record of the species of the trees dug up and no indication that any of them were bald cypress. Such remains were found in several places and at various depths, even 48 feet below the surface, and as they were discovered before the streets had been graded and the contour of the surface changed by cutting and filling there can be no suspicion of their having been buried artificially. The records of these early discoveries dispose of the argument that such well preserved tree remains must necessarily have been buried artificially but a few years ago.

Finally, the muck bed found in the Walker Hotel excavation is by no means so unique as many people have supposed. What is presumably the same bed was encountered, at the same depth, in excavating for the foundations of Stoneleigh Court, a large apartment house built a number of years ago on the east side of Connecticut avenue about 100 yards south of the Walker Hotel. Apparently the top of the same bed was exposed, though no stumps were reported, in digging the cellar of the Rauscher building, across Connecticut avenue from Stoneleigh Court. A similar bed must have been exposed somewhere in the city many years ago, as a brief account of the geology

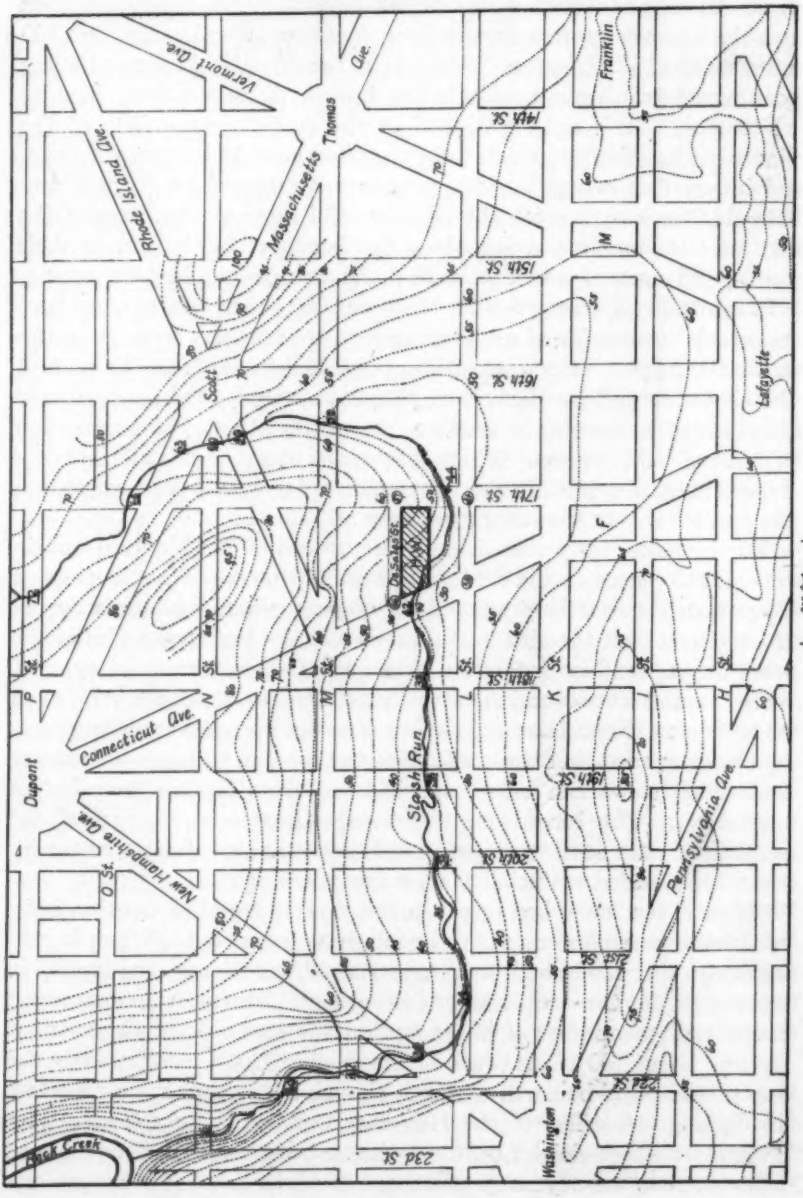


Fig. 1. Generalized contour map of the lower part of Slash Run valley as it was when the city of Washington was laid out. (For explanation see body of text.)

of Washington, written before 1860, in describing the strata upon which the city is built, mentions beds of peat and other vegetal material, interstratified with beds of gravel, sand, and clay.

GEOGRAPHIC EVIDENCE

When the city of Washington was laid out the relief of the land now occupied by it was greater than at present and many features have since been obliterated by the grading of streets, cutting down of knolls, and filling up of ravines. No contour map of the original surface was made and the contours on the oldest existing contour map of the city proper, which was made in 1863, after the surface had been considerably modified, were drawn mainly with reference to established street grades and with little regard to the form of the surface inside the squares. However, early in the nineteenth century, after the streets had been surveyed and opened through the woods and brush, lines of leveling were run along the centers of all the streets and the altitudes of the street intersections and of other important points in the streets were determined, as a preliminary step to the establishment of grades. The altitudes were plotted on a large-scale street map which is preserved in the office of the District Engineer of Highways, and material is thus available for the construction of a contour map that will show approximately the relief of the original surface. Several published maps made from early surveys show accurately the former courses of the small streams, but no one seems to have thought it worth while to map the positions and outlines of the swamps.

Figure 1 is a map of the part of the city in which the Walker Hotel is situated, showing the former course of Slash Run and, by five-foot contours, approximately the original form of the surface in the lower part of Slash Run valley. The contours were drawn partly by Dr. N. H. Darton, of the Geological Survey, and partly by the author, from data taken from the old map showing the original altitudes, mentioned in the preceding paragraph. They are, of course, constructed by interpolation, but are accurate for the points where they cross the streets, though necessarily only approximately located between the streets. The italic figures give the altitude of the contours above sea level, the underscored figures the altitude of the bed of Slash Run where it crossed the streets, and the figures in circles the present altitude of street intersections near the site of the hotel, which is the diagonally cross-lined space.

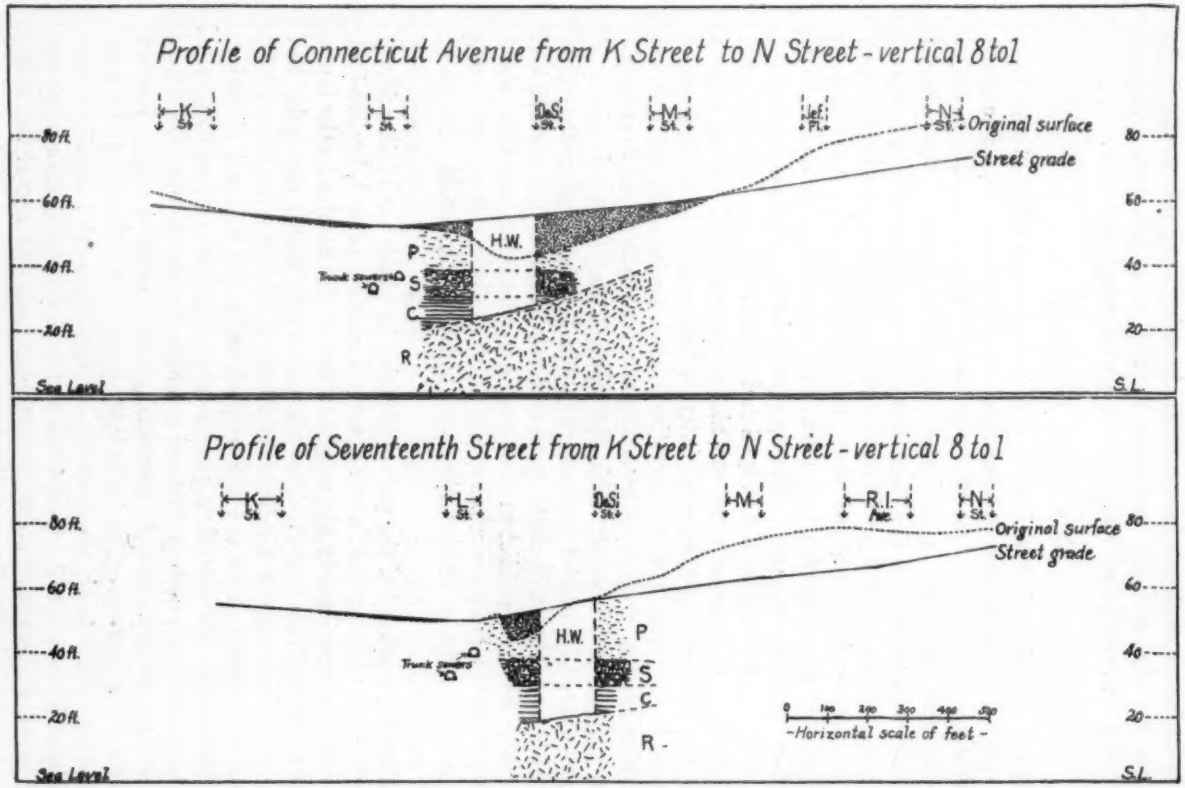


Fig. 2. Profiles showing the relation of the present and original surface in the vicinity of the Walker Hotel. H. W.—Walker Hotel; P—Wicomico formation (Pleistocene); S—Stump bed and muck layer (Pleistocene); C—Patuxet formation (Cretaceous); R—Crystalline rock (Pre-Cambrian).

This map shows that in the vicinity of the hotel site there was a rather steep descent from Rhode Island avenue to the north bank of Slash Run and a more gentle rise from the south bank of the stream to I street, and that the stream flowed through the area now occupied by the hotel in a ravine in which there was no room for a swamp. It also shows that through most of its lower course the fall of the stream was too rapid for the formation of a swamp. In two places, however, one east of Seventeenth street and the other west of Nineteenth street, where the valley was wider and one bank of the stream was lower than elsewhere, the stream may have flooded the valley bottom during freshets and may thus have formed somewhat marshy areas. Finally, comparison of the present altitudes of the street intersections with the former altitude of the surface shows the amount by which the surface has been raised by filling. This ranges from nothing at the northeast corner of the hotel site to 12 feet at the northwest corner, but at one place in the channel of the stream the depth of fill shown in the excavation was about 15 or 16 feet.

The top of the stump bed is 16 to 20 feet below the present surface and as the depth of fill was nowhere greater than 12 feet, except in the stream channel and there only in deep holes, the stumps clearly can not be those of trees that were growing on the banks of the stream before the fill was made and within the memory of living persons. This is more clearly brought out by Figure 2, which shows two profiles, with a vertical exaggeration of 8 to 1, drawn along the centers of Connecticut avenue and Seventeenth street, respectively. The profiles show the present grade and the original surface and thus the amount of cut or fill, the fill being indicated by a stippled pattern. They also show the position of the hotel excavation, projected into the planes of the profiles, the positions and thicknesses of the geologic formations exposed, and the approximate position of the crystalline rock surface. They present incontestable evidence of the correctness of the conclusion of the geologists that the stump bed represents an ancient swamp that existed in a former geologic epoch, that was not exposed at the surface during the early history of Washington as a city, and that had no relation to Slash Run.

P—Wicomico formation (Pleistocene); S—Stump bed and muck layer (Pleistocene); C—Patuxet formation (Cretaceous); R—Crystalline rock (Pre-Cambrian).

PHYSIOGRAPHIC RELATIONS

The muck bed was found at nearly the same level in all parts of the hotel excavation and has been encountered at that level on the south side of I street, 100 yards south of the hotel. It therefore underlay

parts of the surface that differed in altitude, before Slash Run was filled in, by at least 16 feet, and it must also underlie areas where there has been no fill. Hence it has no relation to the recent topography and must have occupied a hollow in a surface existing at some time during the Pleistocene epoch. As the average thickness of the bed is about 8 feet it must represent a swamp that was in existence for a long time. The swamp could have extended but a short distance northwest of the hotel site, as the muck bed was not encountered in excavating for the foundations of the Connecticut apartment house, at the southwest corner of Connecticut avenue and M street, where the crystalline rock surface was reached at no great depth. On the other hand it may have extended some distance southeastward, as there are indications of a shallow trough, trending in that direction, in the surface of the Cretaceous beds.

The cypress swamp must have been but little above the base level of drainage in the Potomac basin at that time. It probably occupied the lower valley of a tributary of the Potomac, perhaps the Rock Creek of that epoch, when the land stood 30 feet or so lower than now with regard to sea level, and when the uplift which caused the stream to excavate its valley had ceased and had been succeeded by a slow subsidence, which allowed the accumulation of 5 to 10 feet of swamp deposit. The subsidence then became more rapid and the swamp was buried by the beds of sandy clay and fine gravel constituting the Wicomico formation. After some later oscillations of level that did not materially affect the history of the Walker Hotel locality the Recent epoch was ushered in by an uplift of the land to a little more than its present height and the development of a new drainage on the emerged surface. Slash Run was formed and began to carve its valley, and it had almost but not quite uncovered the old stump bed when man interfered and put an end to its activities.

Buried muck and peat beds containing cypress stumps and wood have been found exposed in cliffs and river banks or have been penetrated in wells at many places in the Coastal Plain from Maryland to Alabama. Nearly everywhere they are overlain by deposits of the Talbot formation of the Pleistocene age and are believed to have been formed in the early part of Talbot time, hence the bed in the Walker Hotel excavation was at first regarded as of Talbot age. Later study led to the view that the overlying sandy clay is part of the Wicomico formation. Furthermore, its altitude above present sea level and its relation to the topography of Pleistocene time make it improbable that the bed can be as young as Talbot. It is now regarded as having been formed in the early part of Wicomico time and hence of mid-

Pleistocene age. Although the Pleistocene formations of the Chesapeake Bay region have not yet been satisfactorily correlated with the drift sheets of the northern United States, there is little doubt that a deposit of early Wicomico age must be older than the Wisconsin drift, if not, indeed, older than the Illinoian drift. The best recent estimates of the date of beginning of the Wisconsin glacial epoch put it not later than 100,000 years ago and the date of beginning of the Illinoian glacial epoch as at least 300,000 years ago. It seems fairly certain, therefore, that the muck bed and the cypress stumps can not well be less than 100,000 years old and that they may be much older.

SUMMARY.

The conclusions of the geologists as to the great age of the stump bed, based on the stratigraphic relations displayed in the excavation, have been confirmed in every respect by the testimony of the leaves, seeds, and diatom remains found in the muck, by the physiographic evidence of the conditions under which the cypress swamp was formed and existed, by the geographic evidence regarding the topography of the lower valley of Slash Run, and by the historical evidence from descriptions published years before the growth of the city had altered the conditions in the locality. It is, therefore, established that the stumps and the muck in which they are imbedded are the remains of a cypress swamp that was overwhelmed and buried by natural processes many thousand years ago and are not, as so many people have supposed, the remains of trees that grew on the banks of Slash Run less than 60 years ago and were cut down and covered by an artificial fill.

It should be said in closing that the geologists make no demur to the recollections of the old residents, but only to the conclusions based on those recollections. The geologists are well aware and admit without question that a stream formerly ran through the locality in a valley that was deeper than it is now; that there may have been marshy spots here and there along its course; that large trees grew on its banks; and that the trees were cut down and the land was filled to some depth about 50 years ago. They insist, however, and have proved, that all this has nothing to do with the muck bed and cypress stumps discovered in the Walker Hotel excavation, at a depth several feet below the bottom of the former Slash Run valley, and that the stump bed is a much older deposit in no way related to the conditions along Slash Run that many people still remember.

Obituary

Mr. ERSKINE DOUGLAS WILLIAMSON, physicist in the Geophysical Laboratory of the Carnegie Institution of Washington, and one of the Editors of this *Journal*, died on Christmas afternoon at about three o'clock at the George Washington University Hospital.

Although only thirty-seven years of age at the time of his death, Mr. Williamson had won for himself an eminent position not only in the scientific life of Washington, but in a wide circle of mathematical physicists and physical chemists in this country and abroad. He was born in Scotland on April 10, 1886, and was educated at the University of Edinburgh, where he took the degrees of Bachelor of Science in 1908 and Master of Arts in 1909. As one of the most promising pupils of Sir James Walker, he was appointed a research assistant under the Carnegie Trust of Scotland. His research work at Edinburgh became known in this country and he was offered an appointment at the Geophysical Laboratory of the Carnegie Institution in 1914. Here, in company with John Johnston and L. H. Adams, he studied the problems of the formation and consolidation of limestone. This work was followed up by research on the physical and chemical effects of very high pressures, in which he did pioneer work in the development of special apparatus and in the measurement of compressibilities of minerals and rocks.

During the War he did his part in aid of the cause of his native country, as well as of the United States, by going into one of the glass plants, in company with other members of the Laboratory force, and assisting in the rapid development of the manufacture of optical glass, a "key industry" in which this country rapidly shook itself free of its former dependence on Germany.

Mr. Williamson's ability as a mathematician was particularly highly valued at the Laboratory, and he made several valuable contributions to the practical problems of the annealing of glass, as well as to the theoretical and highly important question of the transmission of earthquake waves through the earth, and the deductions concerning the constitution of the earth's interior, which can be drawn from these facts.

Mr. Williamson was active in the local scientific organizations, having been a member of committees in the American Chemical Society and the Philosophical Society of Washington, and one of the editors of the *Journal* of the ACADEMY, of which he would have become Senior Editor in January. He was also a member of the American Physical Society and the Mathematical Society of Edinburgh.

The Editors wish to put on record their appreciation of his self-sacrificing devotion to the editorial work of the *Journal*, which he continued until forced by illness a few weeks ago to relinquish the duties, and of their own keen sense of loss in the sudden death of their colleague.